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Review

Is open surgery or endovascular therapy best to treat acute mesenteric occlusive disease?



S.F. Smith^a, N.D. Gollop^{b,*}, S.G. Klimach^c, P.J. Murray^b

^aSchool of Clinical Medicine, University of Cambridge, UK

^bThe Norfolk and Norwich University Hospital, Norwich NR4 7UY, Norfolk, UK

^cBrighton and Sussex Medical School, University of Sussex, Brighton, UK

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ABSTRACT

A best evidence topic in vascular surgery was written according to a structured protocol. The question addressed whether endovascular treatment improved peri-operative outcomes when compared to an open approach to restore arterial perfusion in acute mesenteric occlusive disease. Four hundred and ninety seven papers were identified using the reported search; of which 4 represented the best evidence to answer the question and are discussed. The evidence on this subject is limited, comprising largely of non-randomised retrospective cohort studies. The evidence suggests that endovascular treatment is associated with reduced mortality and has better short-term peri-operative outcomes, as well as longer-term survival – however many endovascular cases require subsequent open surgery. There is also conflicting evidence to suggest endovascular therapy is associated with longer ICU stays. Aside from procedural complications, factors such as patient status, time delay to diagnosis and treatment may play a greater role in determining mortality rates. In summary, endovascular therapy appears to be a feasible treatment option with post-operative complications and inpatient mortality rates lower than those seen in open surgery.

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1. Introduction

A best evidence topic was constructed according to a structured protocol. This is fully described in a previous publication in the International Journal of Surgery.¹

2. Clinical scenario

You have been called to see a 71-year old male who has been diagnosed with acute mesenteric occlusive disease following a diagnostic emergency mesenteric CT angiogram. Your colleague recommends the patient undergo urgent revascularisation using an endovascular treatment approach, stating “this approach has been shown to have fewer post-operative complications and lower mortality rates compared to traditional open surgery”. You resolve to consult the literature to assess the evidence base for

the surgical management options of acute mesenteric occlusive disease.

3. Three-part question

In patients who require treatment to restore arterial perfusion in acute mesenteric occlusive disease, does an endovascular approach as compared to an open approach improve clinical outcomes, including morbidity and mortality?

4. Search strategy

Medline search 2000–2013 using the PubMed interface for the terms: Search ((((((open surgery) AND endovascular) AND acute mesenteric occlusive disease) OR acute mesenteric occlusion) OR acute mesenteric ischaemia) OR acute mesenteric ischaemia) OR acute mesenteric ischaemic disease) OR acute mesenteric ischaemic disease NOT chronic) NOT CT) NOT cardiac) NOT coronary) AND Humans[Filter]).

In addition, the reference lists of the relevant papers were searched. The search was current as of 12th February 2013.

* Corresponding author. Tel.: +44 (0) 1603 286286; fax: +44 (0) 1603 286428.
E-mail address: n.gollop@doctors.org.uk (N.D. Gollop).

5. Search outcome

In total, 497 papers were found using the reported search. From these, 114 were not in English and were excluded. There were 31 articles directly relevant to the question asked – of these, 7 were general articles focussing on the pathophysiology of acute mesenteric ischaemia, 5 were articles detailing surgical techniques, 2 described the aetiology of disease, 5 were case studies and there was 1 opinion-based article. 4 papers either directly compared clinical outcomes of open surgery and endovascular revascularisation in acute mesenteric occlusive disease or contained clinical outcome data of one of the techniques. These papers were therefore chosen as representing the best evidence to answer the clinical question.

6. Results

The results of the 4 papers (4 retrospective cohort studies) are summarised in [Table 1](#).

7. Discussion

All of the four retrospective studies included in this review compared mortality rates among patients who received endovascular thrombolysis to those who underwent open emergency laparotomy treatment. In a 2011 study, Arthurs et al.,² ($n = 70$) found that inpatient mortality was significantly lower when an endovascular approach was used compared to an open approach (36% vs. 50%; $p < 0.05$). Block et al.,³ also posited a lower 30-day mortality rate with endovascular thrombolytic therapy compared to open surgery (28% vs. 42%; $p = 0.03$). Barakate et al.,⁴ presented a small-scale study ($n = 8$) which found that inpatient mortality was 57% among patients who underwent open surgery to treat superior mesenteric artery (SMA) occlusion, vs. no mortality for endovascular repair. However, in 2012, Ryer et al.,⁵ presented a retrospective cohort study of 93 patients with acute mesenteric ischaemia which failed to establish a significant difference in clinical outcomes between open and endovascular revascularisation.

Various factors should be considered when forming conclusions from these results. Firstly, the clinical diagnosis of acute mesenteric ischaemia is, arguably, not clear-cut. At present, diagnosis of acute mesenteric ischaemia is primarily based on clinical presentation and radiographic findings (CT angiography). Whilst some studies suggest there are highly sensitive and specific plasma biomarkers for acute mesenteric ischaemia in humans (e.g. I-FABP: 100% Sensitivity, 96% Specificity – Kanda, 1996⁶), these biomarkers are not used for definitive diagnosis as the evidence is controversial (Block et al., 2008 suggests plasma biomarkers I-FABP, α -glutathione S-transferase, D-lactate and creatine kinase B, do not differ amongst AMI patients and controls). The clinical presentation of acute mesenteric ischaemia differs from that of a chronic mesenteric ischaemia (CMI), with patients of the former often presenting with sudden onset of severe abdominal pain, whilst the latter complain of ongoing symptoms including post-prandial abdominal pain and subsequent weight loss. Usually in CMI, the development of a collateral circulation prevents infarction occurring. However CMI patients with advanced disease could potentially present in an identical manner to AMI patients, where either thrombosis or embolus occurs in a narrowed artery. These patients with “acute on chronic” mesenteric ischaemia could therefore be misclassified as AMI patients in the studies considered in this review. It has been established that CMI patients who undergo open procedures develop increased rates of complications peri-operatively than endovascular revascularisation.⁷ Of the 4 studies, Arthurs et al.²

excluded patients “presenting with AMI secondary to mesenteric venous thrombosis, non-occlusive mesenteric ischaemia, aortic dissection complicated by visceral ischaemia due to investigational device exemption protocol”. Similarly, Barakate et al. only included patients with ischaemia due to acute SMA occlusion (based upon CT scanning, angiography or operative findings) and Ryer et al. stated that patients with “sub-AMI were excluded from the analysis”. Interestingly, Ryer et al. reported that approximately 40% of their patients had symptoms suggestive of chronic mesenteric insufficiency (which corresponded to more than 40% of their patients having necrotic bowel at their initial laparotomy). Block et al.³ took a different approach, including patients with symptoms of previous chronic mesenteric ischaemia if they presented with an acute onset of intestinal ischaemia.

Secondly, mortality outcomes vary amongst the studies discussed, whilst Block and Ryer described thirty-day mortality, Arthurs and Barakate described inpatient mortality (Arthurs do not discuss the length of inpatient stay before discharge, but the patients who survived in Barakate’s study were discharged between 9 and 28 days).

Thirdly, one must consider that there are inherent difficulties in studying management of AMI patients. The cohort sizes in the studies discussed are generally very small, the investigators being limited by the low incidence of AMI. This particularly limits the reliability of conclusions based on mortality rates from Barakate’s study, which included 7 patients who underwent open treatment and just 1 who underwent endovascular thrombolysis. In addition, again due to the low incidence of the disease, often the study period may last several years or even decades. As such, the usefulness of such a study might be questionable given improvements in treatment protocols with time (particularly so for endovascular thrombolysis). This is exemplified in Ryer’s retrospective study which followed 93 patients presenting with AMI between 1990 and 2010, which reveals an improvement in overall thirty-day mortality rates from 27% in 1990s to 17% in 2000s (with no significant difference between open and endovascular revascularisation).

Whilst the question of interest in this review is a direct comparison of laparotomy to an endovascular approach, there are inherent difficulties in interpreting the clinical outcomes due to issues of selection bias and problems in clearly delineating the management options described. Due to the design of Arthurs’ study, cohorts were non-randomised and therefore open to selection bias – deteriorating patients were more likely to be managed by an open approach (and hence, arguably, have worse outcomes due to a worse clinical starting point). The retrospective studies often include patients who have undergone both approaches (i.e. endovascular therapy followed by laparotomy), which makes it difficult to analyse the data on a scale larger than an individual patient basis. In Arthurs study, 69% of those who underwent endovascular treatment subsequently required a laparotomy (these patients showed signs of peritoneal inflammation or clinical deterioration following revascularisation) – arguably, some might find it difficult to therefore see the benefit of endovascular treatment. However, for those patients who underwent endovascular treatment with subsequent conversion to an open approach, the median lengths of necrotic bowel resected were significantly shorter (52 cm vs. 160 cm; $p < 0.05$), in patients who had been treated with endovascular therapy prior to open surgery.

Peri-operative morbidity is a major consideration when making clinical judgements for the management of AMI patients. In Arthurs’ study, they noted that complications such as acute renal failure (50% vs. 27%; $p < 0.05$) and respiratory failure (64% vs. 27%; $p < 0.05$) were significantly lower in patients treated with an endovascular approach surgery reducing the likelihood of post-operative short bowel syndrome.

Table 1
Best evidence papers.

Author, date and country	Patient group	Study type and level of evidence	Outcomes	Key results	Comments
Arthurs et al., 2011 ² USA	70 patients with acute mesenteric ischaemia presenting between 1999 and 2008 (mean age, 64 ± 13 years). Aetiology: thrombotic 65%, embolic 35%. Endovascular revascularisation was the preferred treatment (81%) vs. operative therapy (19%).	Level III retrospective cohort study	Survival (Open surgery vs. Endovascular)	Inpatient mortality: 50% vs. 36% ($p < 0.05$) Mortality of endovascular failures: 50% Endovascular therapy associated with improved mortality in thrombotic AMI (OR 0.10; 95% CI, 0.10–0.76; $p < 0.05$)	This study retrospectively evaluated the outcomes of a cohort of patients who underwent endovascular revascularisation (81%) or operative therapy (19%) for treatment of acute mesenteric ischaemia. Successful endovascular treatment was achieved in 87% of patients. However, laparotomy was still necessary for 69% patients undergoing endovascular therapy. Endovascular therapy was associated with reduced mortality rates, and improved clinical outcomes. The cohorts were non-randomised, there may be confounding factors contributing to the observed improved outcomes. It should be noted that there is an inherent selection bias – perhaps deteriorating patients are more likely to be managed with an open approach (and hence have worse outcomes) whilst healthier patients were more likely to receive endovascular therapy.
			Other outcomes (Open surgery vs. Endovascular)	Laparotomy requirement: 100% vs. 69% ($p < 0.05$) Median length of bowel resected (if laparotomy required following endovascular treatment): 160 cm vs. 52 cm ($p < 0.05$) Acute renal failure: 50% vs. 27% ($p < 0.05$) Respiratory failure: 64% vs. 27% ($p < 0.05$) Thirty-day mortality rate: 42% vs. 28% ($p = 0.03$) 1 year mortality rate: 58% vs. 39% ($p = 0.02$) Long-term survival after endovascular treatment was better than after open surgery (log-rank, $p = 0.02$).	
Block et al., 2010 ³ Sweden	121 open and 42 endovascular revascularisations of the SMA at 28 hospitals between 1999 and 2006.	Level III retrospective cohort study	Survival (Open surgery vs. endovascular thrombolytic therapy)		This study provides good evidence that an endovascular approach is associated with lower mortality rates and better long-term survival than an open operative approach to treatment. This study was limited by the lack of randomisation and selection bias associated with retrospective studies. Differences in outcome may have been due to differences in disease severity, the authors noted that CRP at admission or time delay to intervention did not differ between the groups.
			Other outcomes	Bowel resection ($p < 0.001$) and short bowel syndrome (SBS; $p = 0.009$) occurred more frequently in the open group, and these were independently associated with increased long-term mortality.	
Ryer et al., 2012, ⁵ USA	93 patients who underwent arterial revascularisation for acute mesenteric ischaemia between January 1990 and January 2010.	Level IV Retrospective cohort study	Survival (Open surgery vs. Endovascular)	No significant difference between open and endovascular revascularisation. Mortality (30-day): 27% (1990s) 17% (2000s) Morbidity: Major adverse events occurred in 47% of patients	This study compared management and outcomes of acute mesenteric ischaemia over the past 2 decades. The study found no significant differences in clinical outcomes between open and endovascular revascularisation.

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Table 1 (continued)

Author, date and country	Patient group	Study type and level of evidence	Outcomes	Key results	Comments
Barakate et al., 2002, ⁴ Australia	8 patients treated for SMA occlusion between 1996 and 2001. Open surgery (<i>n</i> = 7) Endovascular thrombolysis (<i>n</i> = 1) Five male and three female patients with a mean age of 71.3 (range 57–88) years.	Level III retrospective cohort study	Other outcomes: Predictors of early mortality (<30 days from initial surgery) Predictors of late mortality (>30 days from initial surgery) Survival (Open surgery vs. Endovascular)	Upon multivariate analysis - Bowel resection at initial surgery (HR, 17.14; 95% CI, 2.00–146.76; <i>p</i> = 0.009) Prior TIA/stroke: (HR, 9.99; 95% CI, 1.86–53.7; <i>p</i> = 0.007). Age (HR, 1.06; 95% CI, 1.01–1.11; <i>p</i> = 0.015), connective tissue disease (HR, 4.92; 95% CI, 1.19–20.21; <i>p</i> = 0.03) major post-operative complication occurrence (HR, 5.25; 95% CI, 1.88–14.67; <i>p</i> = 0.0015). Inpatient mortality: Open 57.1% vs. Endovascular 0%	This study found better mortality rates with endovascular therapy. However only 1 patient was treated with endovascular therapy. The small cohort size limits the usefulness of this review in answering the clinical question.
			Other outcomes	Follow-up: Open – 3 patients alive and well at mean 2.8 years follow-up Endovascular – pain relieved within – hour of SMA urokinase thrombolysis. Patient well at 6-weeks follow-up with normal bowel function.	

With regards to long-term survival, Block et al.,³ noted a reduction in 1-year mortality rates (39% vs. 58%; *p* = 0.02) and improved long-term survival with endovascular treatment (log-rank, *p* = 0.02). Since the patients included in the study were non-randomised, homogeneity between groups was analysed. Factors including age, gender, delay to treatment, symptom onset, occurrence of vomiting, diarrhoea, haematochezia, risk factors (smoking, cardiovascular disease, prior vascular surgery) were not significantly different between the 2 groups. However, patients who underwent open surgery had a significantly higher rate of atrial fibrillation (*p* = 0.031) and a significantly reduced subsequent history of abdominal angina (*p* = 0.042) than those who were in the endovascular repair group. This could be a potential source of bias in the outcomes reported. The authors noted that short bowel syndrome (Hazard Ratio (HR), 2.6; 95% Confidence Interval (CI), 1.3–5.0; *p* = 0.005) and age (HR, 1.03/year; 95% CI, 1.00–1.06; *p* = 0.039) were predictors of decreased long-term survival. Furthermore, Ryer et al.,⁴ presented predictors of late mortality (>30 days from initial surgery) upon multivariate analysis included age (HR, 1.06; 95% CI, 1.01–1.11; *p* = 0.015), connective tissue disease (HR, 4.92; 95% CI, 1.19–20.21; *p* = 0.03), and having a major post-operative complication (HR, 5.25; 95% CI, 1.88–14.67; *p* = 0.0015).

In the study by Barakate et al.,⁴ the patient who received endovascular thrombolysis was an 84-year old male who presented with a history of 12-h of periumbilical pain, nausea, and co-morbid atrial fibrillation. Whilst this patient was not overtly young or healthy, it could be argued that he presented with a less severe form of the disease (i.e. no vomiting/diarrhoea). Usually emptying of the gut by vomiting and/or diarrhoea is the result of bowel wall spasm following bowel wall hypoxia. It should also be noted that the patient who underwent endovascular treatment required a longer stay in intensive care (15 days total) than the 3 patients who survived open repair (ICU stays required by 2 of the 3 patients, lasting 6 and 8 days respectively).

8. Clinical bottom line

As acute mesenteric occlusive disease is a rare condition with an overall prevalence of 0.1% of all hospital admissions, there have been no large-scale high quality studies on this topic and other factors such as time to diagnosis and treatment may play an important role in determining mortality rates. From the data available, the best evidence suggests that endovascular therapy is a feasible treatment option with post-operative complications and inpatient mortality rates lower than those seen in open surgery, however many endovascular cases require subsequent open surgery. However, there is also conflicting evidence to suggest endovascular therapy is associated with longer ICU stays. There may be a role for endovascular thrombolysis prior to open surgery to reduce the length of bowel resected. These conclusions are limited by the small size of the studies and difficulties in differentiating acute from acute-on-chronic presentation. Aside from procedural complications, factors such as patient status, time delay to diagnosis and treatment may play a greater role in determining mortality rates. Therefore, until further evidence is available, it would seem sensible to decide management on a case-by-case basis.

Ethical approval

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Author contribution

SFS – main author.

NDG – designed title, performed searches and reviewed article.

SGK – reviewed article and repeated searches.

PJM – reviewed article and repeated searches.

Conflict of interest

We have no conflicts of interest.

References

1. Khan OA, Dunning J, Parvaiz AC, Agha R, Rosin D, Mackway-Jones K. Towards evidence-based medicine in surgical practice: best BETs. *Int J Surg* 2011;**9**(8):585–8.
2. Arthurs ZM, Titus J, Bannazadeh M, et al. A comparison of endovascular revascularization with traditional therapy for the treatment of acute mesenteric ischemia. *J Vasc Surg* 2011;**53**(3):698–704.
3. Block TA, Acosta S, Björck M. Endovascular and open surgery for acute occlusion of the superior mesenteric artery. *J Vasc Surg* 2010;**52**(4):959–66.
4. Barakate MS, Cappe I, Curtin A, et al. Management of acute superior mesenteric artery occlusion. *ANZ J Surg* 2002;**72**(1):25–9.
5. Ryer EJ, Kalra M, Oderich GS, et al. Revascularization for acute mesenteric ischemia. *J Vasc Surg* 2012;**55**(6):1682–9.
6. Kanda T, Fujii H, Tani T, et al. Intestinal fatty acid-binding protein is a useful diagnostic marker for mesenteric infarction in humans. *Gastroenterology* 1996;**110**:339–43.
7. Gupta PK, Horan SM, Turaga KK, Miller WJ, Pipinos II. Chronic mesenteric ischemia: endovascular versus open revascularization. *J Endovasc Ther* 2010;**17**(4):540–9.